I. C. 6926 DECEMBER 1936

DEPARTMENT OF THE INTERIOR

UNITED STATES BUREAU OF MINES
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OPEN SCHEDULES FOR GOLD AND SILVER ORES AND CONCENTRATES AT WESTERN CUSTOM SMELTERS

BY

E. D. GARDNER AND PAUL T. ALLSMAN

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OPEN SCHEDULES FOR GOLD AND SILVER ORES AND CONCENTRATES AT WESTERN CUSTOM SMELTERS[1]

By E. D. Gardner[2] and Paul T. Allsman[3]

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INTRODUCTION

This is one of a series of papers written for the consideration of operators of small gold and silver mines in the West. The paper discusses smelting schedules, general smelting practices that have a bearing on rates, and the reasons for penalties or credits for certain constituents of ores.

Crude gold and silver ores generally are shipped to smelters only when milling facilities are not available; however, high tailing losses in milling a high-grade or refractory ore or low smelting rates because of the fluxing value of an ore may make direct smelting more economical.

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6926."

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Gold and silver ores or concentrates are smelted at both lead and copper smelters; one of these base metals is required to collect the precious metals during the process of smelting. Ores that do not contain enough copper or lead t collect the gold and silver must be mixed with others that contain an excess of one of the base metals.

ACKNOWLEDGMENTS

The smelting companies kindly furnished copies of their open schedules for publication, and a large number of small producers submitted smelter settlement sheets to the authors for inspection.

Literature on smelting practices at various plants and the metallurgical effects of various ore constituents on the economics of smelting have been consulted; references are given in the text.

CLASSIFICATION OF GOLD AND SILVER ORES

The gold in an ore may be free, but generally it is associated with sulphide minerals; silver rarely exists in the native state. Gold and silver concentrates usually consist mostly of sulphides, and the precious metals usually, but not always, are associated with lead or copper or both. The gangue of an ore may consist of a single mineral, but usually it is a combination of many.

In general, ore is classified as being either siliceous or basic, in accordance with the composition of the gangue. A siliceous ore is one in which silica and alumina exist in excess over iron plus lime; when the reverse is true the ore is termed basic. The silica (SiO_2) in the ores and fluxes received at western smelters may be in the form of quartz or in combinations with other elements as silicate minerals. The alumina in ores occurs as a constituent of various minerals, chiefly in the form of the silicate. The iron usually is in the form of sulphide, but occasionally it exists as an oxide; for purposes of fluxing, iron may be replaced in part by manganese. The iron sulphides generally are changed to oxides by roasting before smelting. Lime may be present as the mineral calcite or in limestone; for fluxing it may be partly replaced in the charge by magnesia or barite.

Crude gold or silver ore that is shipped to a smelter usually contains an excess of silica over iron and lime; concentrates generally contain an excess of iron.

Ore with lead or copper or both would be classified as gold-silver-copper or gold-silver-lead, depending upon the predominant base metal.

Western smelting companies usually classify ore as follows:

(1) Iron ore, which consists mainly of iron sulphide with smaller quantities of copper sulphide or galena. Sulphide concentrates are in this class.

(2) Siliceous iron ore containing silica and iron or their replacement constituents in nearly the proportion to be self fluxing.

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(3) Siliceous ore, which is very high in silica. Siliceous ores are frequently needed at copper smelters for fluxing excess iron in other classes of ore or concentrates. Highly siliceous ore (over 60 percent silica) is used for fluxing off the iron during the converting of copper matte to blister copper. Usually lead smelters do not need such ores, and a penalty is charged for the silica they contain.

SMELTING

A concentrate usually will contain enough lead or copper or both to be a source of revenue to the shipper; occasionally the base metals in a crude ore will also be important. An ore or concentrate that contains an appreciable amount of lead would likely be sent to a lead smelter while ore high in copper and low in lead would go to a copper smelter.

Some gold and silver concentrates contain a high percentage of zinc. Although the gold and silver can be recovered from the residue from zinc retorts, the freight on the ore or concentrate to remote plants and on the residue back to a copper or lead smelter together with total treatment charges generally make it more economical to ship the product to a smelter in the first place and pay the penalty for the excess zinc. Gold and silver in zinc concentrates treated at the Bunker Hill electrolytic zinc plant at Bradley (Idaho) and the Great Falls electrolytic zinc refinery of the Anaconda Copper Co. are recovered in the slime. Only ore, however, with an economic freight range can be handled at these plants.

Copper Smelting

The smelting process consists of melting ore with suitable flux into a molten bath; a gravitational separation then takes place between the products that contain the valuable minerals and the lighter worthless slag.

In copper smelting the slag is skimmed or run off from the top of the bath, and the matte, which contains the valuable minerals, is "tapped off" at the bottom. The matte is composed of copper and iron sulphides; it contains the copper, gold, silver, and small amounts of other metals. The chief constituents of the slag are silica, iron oxide, and lime. The slag usually also contains most of the other worthless material in the charge.

The slag must have a low melting range and be lower in specific gravity than the matte to make a clean separation. Taken singly, neither silica nor lime melts at a temperature metallurgically feasible, and iron oxide requires a rather high temperature. When heated together in proper proportions these constituents react to form a slag of low melting range and of low specific gravity.

The cost per ton of ore treated or the cost per pound of metal recovered is the all important consideration in the smelting process. The entire bulk of the ore must be melted after roasting, and therefore the amount of fuel required to raise the temperature to the melting point is important. Any combination of the metals that form the matte melts at a much lower temperature than the constituents that form the slag, and the relative bulk is much smaller. The economy of forming the slag is therefore the basis of control.

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Generally some of the sulphur is removed by roasting before the ore is introduced into the furnace; a part is contained in the matte, and the rest, in the form of sulphur dioxide, goes up the stack. Many other elements, in smaller amount, may go either wholly or partly into the slag, matte, flue dust, or flue gas. The effects of deleterious elements upon smelting are discussed later.

The copper is reduced to the metallic state from the matte in converters; it contains the gold and silver that are recovered later in the refining process.

Ore deposits rarely contain in themselves the various constituents in the proper proportion for efficient smelting. It is therefore desirable that different types of ore be mixed at the smelter to obtain the proper combination of fluxing materials. Some mining companies with their own smelters are able to produce different types of ores from different sections of their mines in the desired proportions for smelting. Moreover, some custom smelters are situated so fortunately that the ores received can be mixed in the right proportion for fluxing without the addition of other material. Usually, however, special efforts must be made to obtain ores with some of the necessary constituents. Fluxes with sufficient valuable metals to pay for the cost of treatment, either fully or in part, are often sought, but some smelters are forced to treat some barren material, particularly limerock, to get a proper mixture when a shortage of iron exists. Ores containing some lime are very desirable in plants where the silica content is high and iron low. Peters[4] and Liddell[5] have discussed this phase of copper smelting explicitly.

Sulphide copper concentrate comprises a large proportion of the material received at most copper smelters. Under present practice, these usually are deficient in silica, which must then be obtained from other sources.

Liddell[6] gives a very concise discussion of the relation of the various constituents desirable in copper smelting, and Hofman and Hayward[7] offer a technical study of the various reactions.

Fulton[8] gives an excellent discussion of smelter and mill rates and schedules. This paper was published in 1915; since that time smelting technique has changed, mines have become deeper, and ore from the lower sulphide zone has increased while ore from the oxidized zone has been largely depleted. The flotation process has increased the predominance of sulphide in the smelter feed and eliminated much of the silica.

4/ Peters, Edward Dyer, The Practice of Copper Smelting: McGraw-Hill Publishing Co., 1911, pp. 23-38.
5/ Liddell, Donald M., Handbook of Nonferrous Metallurgy: Vol. 2, McGraw-Hill Publishing Co., 1926, p. 939.
6/ Liddell, Donald M., Work cited (footnote 5) pp. 938-940.
7/ Hofman, H. O., and Hayward, Carle R., Metallurgy of Copper: McGraw Hill Book Co., New York City, 2nd Ed., 1924, pp. 150-152.
8/ Fulton, Charles H., The Buying and Selling of Ores and Metallurgical Products Tech. Paper 83, Bureau of Mines, 1915, pp. 15-18.

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Effects of Impurities in Copper Smelting

The impurities that interfere with the economical production of copper of a purity suitable for the market may be divided into two classes - (1) those that interfere in the smelting process and (2) those that go into the blister copper. These of the latter class are partly or wholly eliminated during the two steps of refining by fire and electrolysis.

Two substances, alumina (Al_2O_3) and zinc as the oxide (ZnO), appear to give the most trouble in smelting. Smelting authorities do not seem to agree on the exact chemistry of the reactions that cause the trouble or the exact amounts of these constituents that may be present without causing difficulty, but in practice they all agree that at times the trouble exists. In general alumina will not cause trouble in amounts under about 10 percent and zinc in quantities of less than about 6 to 8 percent. With more than these amounts present refractory compounds are formed, and high temperatures are required to maintain a liquid bath and prevent freezing.

According to Hofman and Hayward, alumina is considered desirable as a basic flux when a deficiency of iron or lime exists, provided a proper ratio exists between the iron and alumina and provided the amount of silica is not excessive.[9] Alumina generally does not receive a credit or penalty in the smelter. Zinc is admitted free up to about 5 to 6 percent, but greater quantities generally are penalized.

When the matte is converted into blister copper, the gold and silver as well as appreciable amounts of zinc, iron, cobalt, tin, nickel, lead, arsenic, antimony, and bismuth, together with rarer elements go into the blister. During the period of fire refining zinc, iron, cobalt, and tin may be completely removed at the beginning. The elimination of nickel, lead, arsenic, and antimony continues throughout the process but is imperfect; silver and bismuth are removed to a very slight extent and gold not at all.[10]

The anodes cast from the fire-refined copper may contain appreciable amounts of gold, silver, nickel, lead, arsenic, antimony, and bismuth. The anodes are then electrolytically refined. The gold and silver are insoluble and are deposited in the mud. The nickel and lead are dissolved before the copper and concentrate in the electrolyte at the expense of copper and sulphuric acid. In concentrations usually found in practice they do not interfere further. Arsenic, antimony, and bismuth are partly dissolved and partly reprecipitated in the mud. They are also partly deposited on the cathode either by electrolytic deposition or mechanically.[11]

The physical properties[12] of copper are affected by all three impurities. One tenth of a percent of arsenic lowers the electrical conductivity[13] of copper about 24 percent and 0.2 percent lowers it 38 percent. Copper containing

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9/ Hofman, H. O., and Hayward, Carle R., Work cited (footnote 7), p. 150.
10/ Hofman, H. O., and Hayward, Carle R., Work cited (footnote 7), p. 272.
11/ Hofman, H. O., and Hayward, Carle R., Work cited (footnote 7), pp. 351-353.
12/ Hofman, H. O., and Hayward, Carle R., Work cited, (footnote 7), pp. 19-23.
13/ Hofman, H. O., and Hayward, Carle R., Work cited (footnote 7), p. 6.

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0.8 percent arsenic is benefitted by increasing its ductility, but when over 1 percent is present it begins to cause red-shortness. One tenth of a percent of antimony lowers the electrical conductivity about 11 percent. Antimony has about the same affect on the ductility of copper as does arsenic, but the percentage is lower since about 0.1 percent causes the copper to crack in rolling. Usually all arsenic and antimony over 1 to 2 percent in the ore is penalized by copper smelters.

Bismuth, in addition to being most difficult to remove, also has the most deleterious affects, as 0.02 to 0.025 percent of the element makes copper brittle at red heat. Fortunately bismuth is not a common constituent of gold and silver ores. Generally, all bismuth over about 0.1 percent is penalized at a high rate per pound.

The penalties applied by the smelters apparently are in proportion to the difficulty experienced in removing the impurities and the varying affects they have on the refined product. Where penalties are not shown in a smelting schedule for any of these deleterious elements it is because the ores received by the smelter do not contain sufficient impurities to be serious.

Lead Smelting

The most important consideration in lead smelting, as in copper smelting, is the composition of the slag. It is desirable to receive ores that upon mixing will contain the proper proportion of different slag-forming substances and will eliminate the necessity for using barren fluxes to satisfy this condition.

In the west, the blast furnace is generally used for smelting lead. In the simplest case, the molten charge is gravitationally separated into lead, matte, and slag, with the lead on the bottom and slag on top. A temperature must be reached at which various substances are entirely fluid, and the specific gravities of the products must have enough difference to give a clean separation.

Less leeway is allowed in the proportions of slag-making constituents in lead smelting than in copper smelting because of the greater number of products separated. The permissible range of silica is narrow, varying between 20 and 36 percent.[14/] The range of iron oxide and lime or their replacement constituents is also limited.

Highly siliceous ore usually is not desirable in lead smelting. A credit generally is given for iron and a penalty charged for the insoluble constituents of the ore. Such constituents, consisting principally of silica with small amounts of other compounds, usually are designated as "insoluble." In some instances when the smelter feed is too basic, due to the presence of crude ore high in iron sulphide or sulphide concentrate, a penalty is applied for the sulphur as it is necessary to use excess fuel to burn off this element in a separate roasting process previous to smelting.

14/ Liddell, Donald M., Handbook of Nonferrous Metallurgy. Vol. 2: McGraw-Hill Publishing Co., 1926, pp. 870-871.

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The function of the blast furnace and details of the desirable and undesirable constituents in practice are discussed by Liddell.[15]

Effects of Impurities in Lead Smelting

Zinc and lead are associated very closely both geologically and geographically. The physical properties of some ores, however, permit a selective separation by flotation, and where this is possible some of the difficulty due to zinc in lead concentrate is removed. Usually about 5 to 8 percent of zinc in an ore or concentrate is not harmful, as it replaces lime as a flux to some extent. When over 5 to 8 percent of zinc is present, a "zinc mush"[16] is liable to form in the furnace as a layer between the matte and slag. This causes serious loss of metal, the tuyeres to clog, and may even cause the furnace to freeze. The excess zinc is always penalized.

The ores received at western lead smelters usually are complex. Silver is associated with the lead in lead ore in such quantities as to make its recovery profitable; in addition, many other elements, such as copper, tin, bismuth, arsenic, antimony, sulphur, iron, nickel, and cobalt, may occur in amounts sufficient to make purification necessary before deliverizing can be carried out.

Removal of impurities[17] from the blast furnace base bullion is usually conducted in three stages - (1) softening to remove the impurities that interfere with the removal of the silver, (2) desilverizing to remove the silver and gold, and (3) refining to remove the zinc used in desilverizing and any impurities that might still remain.

In purifying lead, arsenic and antimony are the most troublesome impurities to remove, with the exception of bismuth, and interfere greatly with desilverizing even when present in very small amounts. By prolonged treatment the amounts can be reduced to a minimum. Next in order among harmful impurities come tin, zinc, sulphur, iron, nickel, and cobalt. These have a greater affinity for oxygen than has lead and can be removed by oxidation and "drossing" at a low red heat. Copper forms an alloy with lead that is less fusible than lead and can be removed by temperature regulation and "drossing." Bismuth cannot be removed by oxidation and stays with the refined lead; when present in amounts over 0.05 percent it imparts a grayish color to white lead, and as an important percentage of commercial lead is used to make this pigment its presence is undesirable. When lead contains more than 0.05 percent bismuth further refining by electrolysis or some other method is necessary. This bad affect of bismuth on white lead, accompanied by the higher cost of purification, accounts for the high penalty imposed on the element by lead smelters.

Three factors usually influence the smelter to apply a penalty and determine its amount; they are (1) the seriousness of the affects of the impurities on the final product, (2) the difficulty and cost of removing them, and (3) the metal

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15/ Liddell, Donald M., Work cited (footnote 14), pp. 870-871.
16/ Liddell, Donald M., Work cited (footnote 14), pp. 881-882.
17/ Liddell, Donald M., Work cited (footnote 14), pp. 902-904.

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losses caused by the quantities present. When penalties are not applied for one or more of these elements it is because they are not present in the ore in sufficient quantities to increase the cost of treatment.

SAMPLING AND ASSAYING

The correct sampling of a lot of ore, as defined by Woodbridge,[18] is the process of obtaining from it a small quantity that contains, in unchanged percentages, all the constituents of the original lot. This must be accomplished by choosing a method of sampling that gives results within reasonable limits of accuracy. The method chosen should be one that can be carried out rapidly and at a low cost.

Usually in gold and silver ores the values occur along the small seams and planes of weakness, and, upon breaking, the fine material carries a greater proportion of the valuable metals than do the coarse pieces. Advantage is taken of this at the Yellow Aster mine at Randsburg, Calif., and other mines as a means of concentrating the valuable metals by merely screening out and discarding the coarse material. Conversely, in some ores the enriched portion is less friable, and the fine material contains less valuable metal than the coarse material; but such instances are rare. Occasionally an ore is encountered in which the valuable metals are disseminated evenly throughout; in such cases obtaining the proper proportion of the different sizes in the final sample will not be so important, but this condition is also rare, and all sampling should be carried out as though the worst condition existed.

Methods of sampling may be divided into two classes, hand and mechanical. These are used separately, or both may be used at different stages of the sampling process. Coning and quartering is the most common form of hand sampling used, and fairly reliable results can be obtained when the fundamental principles are understood and practiced. Mechanical samplers are made by many equipment companies and with many local variations are used extensively at sampling plants. Mechanical sampling is the more accurate when the design and use are correct but may give far worse results than hand sampling when it is not used properly. Errors in hand sampling are likely to be compensating, but those introduced into mechanical sampling by poor design or by parts being allowed to wear out are very apt to be cumulative and give consistently high or low results.

The final ground product usually is divided into four 2-pound samples. One sample is used for making the assay at the smelter, one is given to the shipper, one is held for possible umpire assay, and the fourth is held in reserve.

Samples for the determination of the moisture are taken either from the to of carload or truck lots of crude ore or during sampling from the product that goes to the final grinding stage. Concentrates are sampled for moisture as received by driving pipes into the mass of material. Pipe samples from concentrates are usually dried and quartered down for assay.

18/ Woodbridge, T. R., Ore-sampling Conditions in the West: Tech. Paper 86, Bureau of Mines, 1916, p. 7.

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Gardner and Leddell[19] and Woodbridge[20] have discussed the theory of this phase of sampling and the more recent practice at numerous plants.

Most lead and copper smelters are equipped with efficient sampling plants.

FREIGHT AND TRUCKING RATES

Ores and concentrates are transported from the western mining districts to the smelters usually by railroad or by trucks. When the quantities to be shipped are large and the distances long railroad transportation generally is the cheapest. For small lots and short distances trucking may be more economical. Moreover, less-than-carload lots usually can be shipped cheaper by truck than by rail.

Gardner[21] summarizes the cost of trucking regular tonnages of ores over good dirt roads where the trucks can be steadily employed and with no shoveling in or out under conditions that exist in gold-mining districts in northwestern Arizona and California in 1935, as follows:

Distance, miles	Average cost per ton mile	Distance, miles	Average cost per ton mile
Up to 1	$0.35	5 to 10	$0.09
1 to 2	.22	10 to 20	.06
2 to 5	.12	20 to 100	.05

Commodity rates on carload lots usually are established by the railroads when regular shipments of ore are to be made. A base rate for low-grade ore is quoted; an increase is made for regular increments in the value of the ore. The average base rate on western railroads is about 1 cent per ton-mile. Rates for large tonnages of low-grade ore may be as low as 1/2 cent per ton-mile; rates on branch roads may be 2 cents or more per ton-mile.

WESTERN SMELTERS

Table 1 is a list of copper smelters and lead smelters in the Western States. Some northwestern ores are shipped to the Tadanac smelter of the Consolidated Mining & Smelting Co. at Trail, British Columbia. As noted in the last column of the table, some of the plants have facilities for treating both copper and lead ores; most of them, however, can treat only one class.

The plants of the American Smelting & Refining Co. and of the International Smelting Co. are primarily custom smelters; most of the others, however, were built to treat company ores, and the custom business is of secondary importance to them.

19/ Gardner, E. D., and Leddell, W. A., Design and Operation of a 4-Ton-Per-Hour Gold and Silver Ore-Sampling Plant: Inf. Circ. 6891, Bureau of Mines, June 1936, 40 pp.
20/ Woodbridge, T. R., Work cited (footnote 18).
21/ Gardner, E. D., Costs of Trucking and Packing Ore in Western Gold Mining Districts; Inf. Circ. 6898, 1936, 17 pp.

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TABLE 1. - Copper and lead smelters in Western States

State	Company	Smelter	Location	Ores treated
Arizona...	Phelps Dodge Corp.	Copper Queen Branch.	Douglas....	Gold, silver, copper, and lead ores and concentrates.
Do.	do.	United Verde Branch.	Clarksdale.	Gold, silver, and copper ores and concentrates.
Do.	do.	Morenci Branch[1/]	Clifton....	Do.
Do.	United Verde Extension Mining Co.	.....	Clemenceau.	Do.
Do.	Magma Copper Co.	.....	Superior...	Do.
Do.	International Smelting Co.[2/]	.....	Miami.....	Do.
Do.	American Smelting & Refining Co..	Hayden[1/]	Hayden.....	Do.
California	do.	.....	Selby.....	Gold, silver, and lead ores and concentrates.
Colorado..	American Smelting & Refining Co..	Arkansas Valley.	Leadville..	Gold, silver, lead, and copper ores and concentrates.
Do.	do.	Durango plant[1/].	Durango....	Gold, silver, and lead ores and concentrates.
Idaho.....	Bunker Hill & Sullivan Mining & Construction Co.	Bunker Hill.....	Bradley....	Do.
Montana...	Anaconda Copper Mining Co.	Anaconda Reduction Works.	Anaconda...	Gold, silver, copper, and zinc ores and concentrates.
Do.	American Smelting & Refining Co..	.....	East Helena	Gold, silver, and lead ores and concentrates.
Nevada....	Nevada Consolidated Copper Co. ..	.....	McGill.....	Gold, silver, and copper concentrates and ores.
Texas.....	American Smelting & Refining Co..	.....	El Paso....	Gold, silver, copper, and lead ores and concentrates.
Utah.....	International Smelting Co.[2/]	.....	Tooele.....	Do.
Do.	American Smelting & Refining Co..	.....	Murray.....	Gold, silver, and lead ores and concentrates.
Do.	do.	.....	Garfield...	Gold, silver, and copper ores and concentrates.
Do.	U.S. Smelting, Refining & Mining Co.	.....	Midvale....	Gold, silver, lead, and zinc ores. Zinc concentrates shipped.
Washington	American Smelting & Refining Co..	.....	Tacoma.....	Gold, silver, and copper ores and concentrates (copper refinery).

1/ Idle June 1936. 2/ A subsidiary of the Anaconda Copper Co.

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SMELTER OPEN SCHEDULES

The smelter-treatment charge is based on the cost of treating a ton of ore. These expenses include labor, fuel, supplies, interest on the capital investment, insurance, taxes, and other charges. Moreover, a profit must be made by the smelting company if it remains in business. The entire metal content of an ore cannot be paid for because losses of metals occur during smelting - the slag always contains some metal, some is lost as fume, and other losses take place elsewhere in the process. The recovery of gold and silver is proportional to the loss of copper or lead in the slag as these metals in the slag will carry their share of the precious metals.

Gold, silver, copper (and at some smelters, lead) are the only metals paid for at copper smelters. Part of the lead contained in the ore is collected from the flue dust, and some smelters (1936) pay for about half of the lead content at a reduced price. Some arsenic and other metals may also be obtained from the flue dust, and a part of the other elements is recovered when copper is refined. However, since these elements occur in small quantities and are only partly recovered, the cost of producing them usually is nearly equal to their value.

Some western gold and silver ores contain small quantities of molybdenum, tungsten, or vanadium, which are not recovered by the smelters. The reasons for penalties and premiums have been covered in the discussion on smelting.

Although copper is recovered in the matte at lead smelters, it is paid for only when the company has a copper furnace in conjunction with the lead plant or when the matte is of a high enough grade to be shipped to a copper smelter; payments for copper are made at rates substantially below the quoted price. The other metals that ore may contain are largely eliminated in the slag and fume, as in copper smelting; their recovery is only incidental to the process and adds appreciably to the cost of smelting.

Flotation concentrates are difficult to handle and increase the cost of treatment, especially at lead smelters. Some smelters make an additional charge for handling this material.

Excessive moisture in an ore or concentrate increases the difficulty of sampling; wet ore balls up and increases the cost of crushing and screening. Penalties for moisture in excess of 6 to 10 percent are charged by some smelters.

The cost of sampling and assaying a small lot of ore is nearly as much as for larger quantities. Usually a flat charge of $5 to $10 is made for all lots of under 7 to 10 tons.

Freight from the shipping point to the plant is always charged to the account of the shipper.

Charges are based on the dry weight of the ore in tons of 2,000 pounds. Penalties and premiums for most substances are figured at so much per unit. A unit is 1 percent of a ton, or 20 pounds.

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Most of the smelting companies, in furnishing the authors with copies of their open schedules, stressed the point that concessions usually can be made in the rates when the shipper can contract to deliver a specified monthly tonnage of ore or concentrate. Moreover, open schedules frequently are modified after one or two shipments are received and the character of the ore becomes known.

Special rates occasionally are offered for ores desired for their fluxing qualities. As the smelting business is competitive, concessions in rates for regular shipments may occasionally be obtained by bargaining.

Schedules at Copper Smelters

Information as to methods of payments, treatment charges, deductions and premiums at seven western copper smelters is summarized in table 2. The same schedules are used in most cases when purchasing intermittent lots of copper ores that contain subordinate amounts of gold and silver.

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TABLE 2.- Schedules for gold and silver ores at copper smelters (July 1936)

Plant	Payments											
	Gold[1]			Silver[2]			Copper[3]			Lead[4]		
	Minimum paid for, ounces per ton	Payments: Classes of ore, ounces per ton	Payments: Rate per ounce	Minimum paid for, ounces per ton	Minimum deduction, ounces per ton	Percent paid for	Deductions: Pounds per ton[5]	Deductions: Cents per pound	Percent of quotation after deduction	Deductions: Units	Deductions: Cents per pound	Percent of quotations after deduction
El Paso.....	0.03	All	$32.31825	-	0.5	6/95	8	2.525	7/95	1.5	3.0	8/60
Garfield[9]	.03	0 to 3 Over 3	31.81825 32.31825	1.0	.5	95	15	2.5	100	0	3.5	10/50
Midvale.....	.02	0 to 5 Over 5	31.81825 (11)	1.0	.5	95	12/15	3.	90	-	-	-
Anaconda.....	.01	All	31.81825	-	1.0	13/95	12/10	2.5	90	-	-	0
Tooele[15]	.02	All	31.85	1.0	-	95	15	2.775	100	-	3.525	10/50
Do.[16]	.02	0 to 3 3 to 6 6 to 10 Over 10	31.85 32.20 32.90 33.25	1.0	-	95	15	2.775	100	-	3.525	10/50
Miami.....	.03	All	32.20	1.0	-	95	17/10	2.5	90	-	-	0
Superior[18] ...	.03	All	32.20	1.0	-	95	19/8	2.5	90	-	-	0
Do.[20]	.03	All	32.20	1.0	-	95	19/8	2.5	90	-	-	0

(Footnotes for Table 2 on page 15.)

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TABLE 2.- Schedules for gold and silver ores at copper smelters (July 1936) - Con'td.

Plant	Deductions										
	Treatment charge				Penalties						
	Base		Add for excess gross value over base percent	Maximum	Zinc		Arsenic (As), antimony (Sb), and tin (Sn)			Bismuth	
	Per ton	Gross value			Units free	Charge per unit for excess	Element or combination	Unit free	Charge per unit for excess	Units free	Charge per pound for excess
El Paso	$3.50	$0 to $20 Over $20	10	$ 6.00	5	$0.30	Arsenic Sb + Sn	2 1	$0.50 1.50	0.1	$0.50
Garfield[9]	3.50	$0 to $20 Over $20	10	5.50	6	.30	As + Sb	2	0.50	--	0
Midvale	5.00	$0 to $30 Over $30	10	7.00	6	.30	--	--	0	--	0
Anaconda	4.00	$0 to $15 Over $15	10	[14] 5.50	--	0	--	--	0	--	0
Tooele[15]	4.00	$0 to $25 Over $25	10	6.00	--	0	--	--	0	--	0
Do.[16]	4.00	$0 to $25 Over $25	10	6.00	--	0	--	--	0	--	0
Miami	3.50 6.00	$0 to $15 $15 to $40 $40 to $100 Over $100	10 5	6.00 8.00	--	0	--	--	0	--	0
Superior[18]	3.50	$0 to $15 $15 to $100 Over $100	10 5	6.00 15.00	--	0	--	--	0	--	0
Do.[20]	2.50	$0 to $15 $15 to $100 Over $100	10 4	5.00 --	--	0	--	--	0	--	0

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FOOTNOTES FOR TABLE 2

1/ Payments on gold are based on the new mint price of $35 per ounce (net $34.9125).
2/ Payments on silver are based on the new mint price for American mined ore at $0.77 per ounce.
3/ Payments on copper are based on the Engineering and Mining Journal quotations.
4/ Payments on lead are based on the New York quotation for common desilverized lead.
5/ When assay is less than the deduction the shipper is charged with the deficiency, except as further noted.
6/ Less a deduction of 1-1/2 cents per ounce.
7/ Nothing paid for copper less than 1/2 percent.
8/ Nothing paid for lead less than 5 percent by wet assay.
9/ Siliceous ore open schedule.
10/ Nothing paid for lead less than 2 percent by wet assay.
11/ On direct smelting ores containing over 5 ounces gold per ton, the price per ounce for the excess will be to the mutual agreement between the buyer and shipper.
12/ Minimum deduction.
13/ Less a deduction of 2 cents per ounce.
14/ To the base treatment charge also add 12 cents for each unit of iron and deduct 2.5 cents for each unit of silica in excess of alumina; treatment charge is not to exceed maximum.
15/ Dry-ore rate.
16/ Gold-concentrate rate.
17/ Minimum deduction 10 pounds and maximum deduction 20 pounds per ton. No payment or deduction will be made when copper is less than 0.8 percent.
18/ Crude-ore open schedule for carload lots.
19/ Minimum deduction 8 pounds per ton and maximum deduction 20 pounds per ton.
20/ Concentrate open schedule for carload lots.

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The following, which is a typical schedule for siliceous ores, is reproduced in its entirety.

SILICEOUS ORE SCHEDULE EFFECTIVE July 7, 1936

To _____

DELIVERY: F.O.B. _____, up to 100 tons per month; excess buyer's option.

PAYMENTS FOR METALS

GOLD: If 0.03 of an ounce per dry ton and up to and including 3.0 ounces, pay for all at $19.00 per Troy ounce; if over 3.0 ounces, pay for all at $19.50 per Troy ounce, plus 90% of realized gold premium in excess of $20.67 per Troy ounce. Under present Government price this is equivalent to paying for 100% at $31.81825 per ounce when under 3.0 ounces and $32.31825 per ounce when over 3.0 ounces gold content per ton.

SILVER: If 1.0 Troy ounce per dry ton or over, pay for 95% at the applicable Handy & Harman quotation, or at the present realized Mint price of 77 cents per ounce, provided silver qualifies for Government purchase and affidavit is furnished; minimum deduction .5 of an ounce.

COPPER: Deduct 0.75 units from wet copper assay and pay for remaining copper at prevailing Electrolytic Cathode quotation, less a deduction of 2.5 cents per pound of copper paid for.

LEAD: Pay for 50% of wet assay less a deduction of 3.5 cents per pound at _____ prevailing lead quotation. No lead paid for if less than 2.0% by wet assay.

QUOTATIONS: Silver, Lead, and Copper quotations are based on average for calenda week including date of arrival of last car of each lot at plant of Buyer, and on a bullion freight rate of $12.50 per ton to New York City.

No payment will be made for any metal or content except as above specified.

DEDUCTIONS

BASE CHARGE: $3.50 per net dry ton on ores having a gross value of $20.00 or less Increase Base Charge 10% of excess gross value above $20.00 up to a Base Charge of $5.50 per ton.

SAMPLING: A flat charge of $5.00 will be made for sampling, handling, and assaying each lot containing less than 10 tons dry weight when value per ton is $200.00 or less. When value per ton exceeds $200.00, sampling, handling, and assaying charge will be $7.50 per lot. No charge will be made for sampling, handling, and assaying lots containing 10 tons or over dry weight.

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IMPURITIES: Zinc: 6% free; charge for excess at 30 cents per unit. Arsenic and antimony combined: 2% free; charge for excess at 50 cents per unit.

FREIGHT: All railroad, freight, and delivery charges are for the account of the shipper. Deduct from Settlement, freight and other advances made by Buyer.

ASSAYING: Buyer's assays will govern if Seller fails to make or submit assays prior to acceptance of payment. Seller should advise at time shipment is made whether or not he desires to submit assays and also direct Buyer where to send control pulp samples.

DURATION: Rates on ores not under contract are subject to change 30 days after date shown above. This rate cancels and supersedes all former rates quoted.

Example of Calculations

The method of calculating returns on a shipment of ore based on the preceding schedule follows:

Wet weight of lot = 36.28 tons.
Moisture = 8.5 percent.
Dry weight of lot = 36.28 (1.00-0.085) = 33.20.

Chemical analysis:

Gold	1.27	ounces per ton.
Silver	2.10	do.
Copper	1.2	percent.
Zinc	6.4	do.
Arsenic	.60	do.
Antimony	.72	do.
Bismuth	.08	do.
Iron	12.4	do.
Sulphur	19.1	do.
Silica	49.7	do.
Alumina	6.0	do.
Total	96.20	do.

Payments:

Gold, 1.27 x 31.81825 =	$40.41
Silver, (2.10 - 0.5) x 0.77 =	1.23
Copper, market quotation 9.5 cents per pound. 20 (1.2 - 0.75) x (.095 - .025) =	.63
Lead, none.	
Gross payments per dry ton	$42.33

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Deductions:		
Treatment charge:		
For $20 gross value, per ton	$3.50	
Plus ($42.33 - 20) 0.1 =	2.23	$5.73
Maximum		$5.50
Penalties:		
Zinc, (6.4 - 6) x 0.30 =		12
Arsenic plus antimony (0.60 + 0.72) - 2.0		none
Total deduction per dry ton		$ 5.62
Net payments per dry ton		36.71
Total returned by the smelter to the shipper 33.20 x 36.71 =		$1218.77

Schedules at Lead Smelters

A tabulation of the open schedules at seven western lead smelters is contained in table 3.

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TABLE 3. - Schedules for gold and silver ores at lead smelters (July 1936)

Plant	Payments: Gold[1] Minimum paid for ounces per ton	Gold[1] Payments: Classes of ore, ounces per ton	Gold[1] Payments: Rate per ounce	Silver[2] Minimum paid for, ounces per ton	Silver[2] Minimum deductions, ounces per ton	Silver[2] Percent paid for	Lead[3] Deduction: Units	Lead[3] Deduction: Cents per pound	Lead[3] Percent of quotation after deduction	Copper[4] Deductions: Pounds per ton	Copper[4] Deductions: Cents per pound	Copper[4] Percent of quotation after deduction	Iron and lime
El Paso	0.03	All	$32.81825	- -	0.5	5/ 95	1.5	1.425	6/ 90	8	5.025	7/ 95	- -
Murray	.02	All	31.81825	1.0	.5	95	1.5	1.5	6/ 90	15	5.5	100	Iron[10] Lime[11]
East Helena[13]	.03	.03 to 3 3 to 5 5 to 10 Over 10	31.81825 32.31825 32.6743 33.0304	- -	1.0	95	1.5	1.5	6/ 90	20	6.0	14/ 100	Iron[15]
Selby[16]	.03	Under 5 5 to 15 Over 15	31.81663 32.31663 32.81663	1.0	1.0	95	- -	- -	0	- -	- -	0	- -
Selby[18]	.03	Under 5 5 to 15 Over 15	31.81663 32.31663 32.81663	1.0	1.0	95	- -	- -	0	- -	- -	0	- -
Leadville[20]	.03	0 to 1 Over 1	31.81825 32.31825	- -	1.0	95	1.5	0	90	20	6.5	100	Iron[21]
Do.[22]	.03	0 to 1 Over 1	31.81825 32.31825	- -	1.0	95	1.5	1.5	23/ 100	20	6.5	24/ 100	Iron[25] Lime[26]
Do.[29]	.03	0 to 1 Over 1	31.81825 32.31825	- -	1.0	95	1.5	1.5	90	20	6.5	100	- -
Midvale	.02	0 to 5 Over 5	31.81825 (30)	1.0	.5	95	1.5	1.5	31/ 90	32/ 15	5.5	90	Iron[33]
Kellog[36]	.05	Under 5 5 to 10 Over 10	31.81825 32.17431 32.53037	1.0	- -	37/ 95	1.25	0	6/ 90	20	8.0	38/ 100	- -
Do.[41]	.05	Under 5 5 to 10 Over 10	31.81825 32.17431 32.53037	1.0	- -	37/ 95	- -	- -	0	20	8.0	38/ 100	- -

(Footnotes for Table 3 on page 21.)

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TABLE 3. - Schedules for gold and silver ores at lead smelters (July 1936) - Con'td.

Plant	Deductions																	
	Treatment charge			Penalties														
				Insoluble		Zinc		Arsenic, antimony, tin (As) (Sb) (Sn)			Bismuth		Sulphur			Moisture		
	Gross value	Base per ton	Maximum	Units free	Charge per unit	Units free	Penalty per unit for excess	Element or combination	Units free	Penalty per unit for excess	Units free	Penalty per pound for excess	Units free	Penalty per pound for excess	Maximum penalty	Units free	Penalty per pound for excess	Maximum penalty
El Paso	0 to $25 Over $25	$3.70 (8/)	$6.70	0	$0.05	5	$0.30	As Sb + Sn	2 1	$0.50 1.50	(9/)	$0.50	2	$0.20	$2.00	- -	0	- -
Murray	(12/)	2.50	- -	0	.10	6	.30	As + Sb	2	0.50	- -	0	2	0.25	2.50	- -	0	- -
East Helena13/	0 to $30 30 to 40 Over 40	6.00 5.50 5.00	$6.00	- -	0	5	0.30	As Sb	2 1	0.50 2.00	(9/)	.50	- -	0	- -	- -	0	- -
Selby16/	All	6.00	6.00	(17/)	0	- -	0	As Sr Sn	1	0.50	0	.50	- -	0	- -	- -	0	- -
Selby18/	0 to $35 Over $35	6.50 (19/)	10.00	- -	0	- -	0	As Sb Sn	1	0.50	0	.50	- -	0	- -	- -	0	- -
Leadville20/	All	6.00	6.00	- -	0	5	.50	As Sb Sn	0.5	1.00	0.05	.50	- -	0	- -	10	$0.05	0
Do.22/	0 to $8 8 to $10 10 to $50	4.00 (27/) (28/)	- -	0	0.05	8	.30	As Sb Sn	0.5	1.00	0.05	.50	1	0.25	2.50	10	0.05	0
Do.29/	All	8.50	8.50	- -	0	8	.30	As Sb Sn	0.5	1.00	0.05	.50	- -	0	- -	10	.05	0
Midvale	(34/)	2.50	- -	0	0.10	6	.30	- -	- -	0	(35/)	- -	2	0.25	2.50	- -	0	- -
Kellogg36/	(39/)	12.00	- -	- -	0	5	.30	As Sb	0	1.00	0	$2.50	4	40/0.25	2.00	6	.20	$2.00
Do.41/	0 to $20 (42/)	6.50	9.00	- -	0	5	.30	As Sb	0	1.00	0	$2.50	4	0.25	2.00	6	.20	2.00

(Footnotes for Table 3 on page 21.)

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FOOTNOTES FOR TABLE 3

1/Payments on gold are based on the new mint price of $35 per ounce (net $34.9125).
2/Payments on silver are based on the new mint price for new American mined ore at 77 cents per ounce.
3/Payments on lead are based on the New York quotation for common desilverized lead.
4/Payments on copper are based on the Engineering and Mining Journal quotations.
5/Less a deduction of 1-1/2 cents per ounce.
6/Nothing paid for lead less than 5 percent wet assay.
7/Nothing paid for copper less than 1/2 percent.
8/Add 10 percent to the base charge for the excess value over $25 per ton.
9/0.1 percent of the wet-lead assay free.
10/Pay for all at 6 cents per unit.
11/Pay for all at 5 cents per unit if 5 percent or over.
12/Add 10 cents to base charge for each unit of lead under 30 percent and deduct 10 cents for each unit of lead over 30 percent.
13/Siliceous ore schedule; schedule for ores and concentrates with an excess of iron are identical except that treatment charge is a flat $5 per ton.
14/Nothing paid for copper less than 1 percent.
15/No credit.
16/Schedule for gold concentrates.
17/Add 10 cents per ton per unit of iron short of 25 units excess over insoluble.
18/Schedule for crude siliceous gold ore.
19/Add 10 percent to the base charge for the excess value over $35 per ton.
20/1934 schedule for irony ores and concentrates; applies only on ores and concentrates containing 20 percent or more of iron excess over insoluble.
21/Excess over insoluble all at 10 cents per unit not to exceed $3 per ton.
22/Crude-ore open schedule.
23/When lead is over 9 cents per pound deduct 25 percent of the excess.
24/When copper is over 15 cents per pound deduct 25 percent of the excess.
25/Pay for iron plus manganese at 5 cents per unit but credit is not to exceed charge for insoluble.
26/All at 8 cents per unit if 10 percent or over.
27/Add 25 percent of gross value to the base treatment charge when it is between $8 and $10.
28/Add 10 percent of the gross value to the base charge when it is between $10 and $50.
29/1934 siliceous ore special for ores with 50 percent excess insoluble.
30/On direct smelting ores containing over 5 ounces gold per ton the price per ounce for the excess will be to the mutual agreement between the buyer and shipper.
31/No payment for lead under 3 percent dry assay.
32/Minimum deduction.
33/All at 6 cents per unit.
34/Based on 30 percent dry lead assay. Debit 10 cents for each unit of lead under 30 percent and credit 10 cents for each unit of lead above 30 percent.
35/The Midvale smelter reserves the right to reject any shipment containing in excess of 0.1 percent bismuth.
36/Lead ore open schedule.
37/Ore over 35 ounces per ton deduct 2 cents per ounce.
38/No payment for copper under 1 percent or when quotation is 8 cents per pound or less.
39/Based on 50 percent lead. Add 10 cents per unit when over 50 percent and deduct 10 cents per unit when under 50 percent.
40/Penalty only applies to ore under 20 percent lead; no penalty for ore 20 percent lead or over.
41/Siliceous ore open schedule; ores containing no lead or under 5 percent for which no payment is made (lead determined by wet method less a deduction of 1-1/4 units).
42/Between $20 and $35, $7.00 per ton; between $35 and $50, $7.50 per ton; between $50 and $75, $8.00 per ton; between $75 and $100, $8.50 per ton; over $100, $9.00 per ton.

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A typical open schedule at a lead smelter, reproduced in full, follows.

DOMESTIC LEAD ORES AND CONCENTRATES

The following terms are subject to the general clauses and are subject to prompt acceptance. Unless shipments are begun within 30 days this quotation is automatically cancelled.

PAYMENTS

GOLD: If 3/100 of an ounce per dry ton or over, pay for all at the rate of $20.00 per troy ounce, plus 90 percent of the realized gold premium in excess of $20.67 per troy ounce. Under present Government net realized price ($34.9125), this is equivalent to $32.81825 per troy ounce.

SILVER: Pay for 95 percent (minimum deduction of one-half ounce) at the average Handy and Harman New York silver quotations for the calendar week, including date of arrival of last car of each lot at plant of Buyer; or, if higher, at the realized Mint price, provided silver qualifies for Government purchase and affidavit is furnished, less a deduction in either case of 1-1/2 cents per ounce. Present Mint price is 77 cents per ounce.

LEAD: Deduct from the wet-lead assay 1.5 units and pay for 90 percent of the remaining lead at smelter quotation less 1.425 cents per pound of lead accounted for. Nothing paid for lead if less than 5 percent by wet assay.

COPPER: Deduct from the wet-copper assay 8 pounds and pay for 95 percent of the remaining copper at the daily net refinery quotations for electrolytic cathodes as published in the Engineering and Mining Journal of New York averaged for the calendar week including date of arrival of last car of each lot at the plant of the Buyer less a deduction of 5.025 cents per pound of copper accounted for. Nothing paid for copper if less than 1/2 percent by wet assay. No payment will be made for any metal or content except as above specified.

DEDUCTIONS

BASE CHARGE: $3.70 per net dry ton of 2,000 pounds; provided the sum of payments for gold, silver, lead, and copper does not exceed $25.00 per ton. Add to the base charge 10 percent of the excess over $25.00 to a maximum charge of $6.70 per ton.

INSOLUBLE: Allow no units free; charge for all at 5 cents per unit, fractions in proportion.

ZINC: Allow 5 units free; charge for the excess at 30 cents per unit, fractions in proportion.

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SULPHUR: Allow 2 units free; charge for the excess at 20 cents per unit, fractions in proportion. Maximum charge $2.00 per dry ton of material.

ARSENIC: Allow 2 units free; charge for the excess at $0.50 per unit, fractions in proportion.

ANTIMONY AND TIN (Combined): Allow 1 unit free; charge for the excess at $1.50 per unit, fractions in proportion.

BISMUTH: One-tenth of one per cent (0.1 percent) of the lead content by wet assay will be allowed free. The excess will be charged at fifty cents (50¢) per pound, fractions in proportion.

MOISTURE: A minimum deduction of one percent will be made from wet weight; when over one percent is contained the actual moisture will be deducted.

DELIVERY: F. O. B. unloading bins.

TAXES: Deduct Federal or State taxes, import duties, stamps, and or other charges now or hereafter imposed.

FREIGHT: All railroad freight and delivery charges for account of shipper. Deduct from settlement freight and other advances made by Buyer.

GENERAL CLAUSES GOVERNING ALL OPEN SCHEDULES

1. Weighing, moisture, and ore sampling (at which seller or a representative may be present) as done by Buyer according to standard practice, promptly after receipt of product, will be accepted as final. The absence of seller or a representative shall be deemed a waiver of the right in each instance. After sampling, the product may be placed in process, comingled, or otherwise disposed of by Buyer. In case of disagreement on assays, an umpire shall be selected in rotation from a list mutually agreed upon, whose assays shall be final if within the limits of the assays of the two parties; and if not, the assay of the party nearer to the umpire shall prevail. Losing party shall pay cost of umpire. In case of Seller's failure to make or submit assays, buyer's assays shall govern.

2. All schedules on ore not under contract for a definite period of time are subject to change without notice.

3. The rates quoted herein are for carload lots. On any lot containing one ton or less there will be a sampling and handling charge of $10.00. This charge will be decreased by $1.00 for each ton in excess of one ton.

4. The rates quoted apply only to ore in bulk. Fifty cents per ton additional will be charged for ore in sacks to cover extra cost of handling.

5. In the event quotation date should fall on a legal holiday or one upon which no quotation is issued, the next succeeding quotation will be used in settlement.

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6. In this schedule where the word "ton" is used it is understood to be a ton of 2,000 pounds avoirdupois; where the word "ounce" is used, as referring to gold and silver, it is understood to mean the troy ounce; and where the word "unit" is used it is understood to mean one percent of a ton, or 20 pounds avoirdupois.

7. In order that delivery of the ore at our plant may not be unnecessarily delayed we make it a general rule that THE FREIGHT CHARGES MUST BE PREPAID OR GUARANTEED BY THE SHIPPER.

8. The rates quoted herein are based on present existing scale for common labor at the Smelting Works, and present published all rail freight rates on lead and copper bullion from smelter to New York City. Any increase or decrease is for account of Seller, and proper deduction or credit shall be made accordingly.

Example of Calculations

The method of calculating returns based on the foregoing schedule follows:

Wet weight of lot, 137.2 tons.
Moisture, 3.0 percent.
Dry weight of lot, 137.2 (1.00 - 0.03) = 133.1 tons.

Chemical analysis:

Gold	0.53	ounces per ton.
Silver	1.65	do.
Lead	2.6	percent.
Copper	.82	do.
Zinc	6.7	do.
Arsenic	2.4	do.
Antimony	1.4	do.
Tin	0	do.
Bismuth	.08	do.
Iron	15.0	do.
Sulphur	19.7	do.
Insoluble	28.0	do.
Lime	5.6	do.
Magnesia	4.8	do.
Loss on ignition	9.6	do.
Total	96.7	do.

Payments:

Gold, 0.53 x 32.81825 =	$17.39
Silver, 1.65 x .95 (0.77 - 0.015) =	1.18
Lead, Less than 5 percent.	None
Copper, Quotation 9.5 cents per pound 0.95 [(0.82 x 20) - 8] x (0.095 - 0.05025) =	.36
Gross payments per dry ton	$18.93

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Deductions:

Treatment charge:		
On ore between $0 and $25 gross value,	$3.70	
Penalties		
Insoluble 28.0 x 0.05 =	1.40	
Zinc, (6.7 - 5) x 0.30 =	0.51	
Sulphur, (19.7 - 2) x 0.20 = $3.54; maximum	2.00	
Arsenic, (2.4 - 2) x 0.50 =	.20	
Antimony and tin, (1.4 - 1) x 1.50 =	.60	
Bismuth, [0.08 - (0.001 x 2.6)] 20 x 0.50 =	.77	
Total deductions per dry ton		$ 9.18
Net payments per dry ton		9.75
Total returned by the smelter to the shipper 133.1 x $9.75 =		$1,297.73

SUMMARY

The smelting business is competitive. Usually rates more favorable to the shipper than shown in the open schedule can be obtained by contracting to furnish a specified monthly tonnage. Moreover, concessions in smelting rates sometimes may be obtained by bargaining.

Before making a smelting contract a shipper should have complete knowledge of the approximate analyses and grade of his ore, the freight rates to competitive smelting plants, and the needs of these plants for his particular types of ore; a more favorable contract probably could be negotiated with a smelting company that needed his type of ore for fluxing purposes than with a plant that did not.

Although most smelter schedules are competitive, there usually is enough variation in the methods of payment and in the charges for different items in the open schedule that more favorable returns occasionally may be obtained for a particular lot of ore at one smelter than at another. It is necessary, of course, to know the grade and character of the ore before the charges can be computed.

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